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EUROPEAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT

CC HIGHLIGHTS

Greetings from London. In this issue is a very significant story for improving aircraft reliability. Swedish off-the-shelf technology has proven itself capable of reducing corrosion, improving avionics reliability, and paying for its acquisition cost in approximately a year. Given today's operational challenges on our aircraft, this could be a significant retrofit to our large aircraft fleets as well as new aircraft. Please read Lt Col Fredell's article on aircraft dehumidification (Site Visit: Munters, page 7).

EOARD personnel are on the move. With great regret we note Dr Kent Miller's move to AFOSR, Lt Col Mark Smith's PCS to Hill AFB, and Col (Sel) John Santiago's upcoming PCS to Space Command. On the other hand, the newest member of the EOARD team is a reservist actually working for the International Office. Maj Robin Sneed is our new editor for the Eurogram. We're a little late giving her our input, so please blame us for anything that slips by her. Our new automated Eurogram process prints out our TDY information for the current Eurogram period, so even if we can't get the details out on a trip, you can see where we have been. Please contact us any time we can provide you with more information on where we have been or where you would like us to go.

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LIAISON OFFICER REPORTS

Dr. Charbel Raffoul
Aeronautical Sciences

Site Visit: Center of Aeronautics, City University, London, UK, 10 Feb 1999, POC: Prof. David Peake, Head of Center.

Originally founded in 1894 as Northampton Institute, City University is situated in Clerkenwell, just north of the City of London. City University has the highest proportion of postgraduate activity of any broad-based UK University institution. With substantial City of London connections, degree ceremonies take place in the historic Guildhall with

the Lord Mayor presiding as Chancellor of the University.
Aeronautical education started in 1909, when Frederick Handley Page (later Sir) gave a series of lectures for engineering students and built a wind tunnel. Engineering degrees with aeronautical specialization were developed after the First World War. Expansion of the facilities and courses occurred in the early 1960s when the Institute pioneered the sandwich undergraduate course scheme. A new course in Air Transport Engineering was also introduced at the suggestion of British European Airways.

Aeronautics activity today includes a course program for the international aeronautical and airline industries. The facilities include eight wind tunnels ranging from large low-speed to transonic and supersonic capabilities. The Center for Aeronautics has well-equipped laboratories and workshops to support post-graduate experimental and computational research work in aerodynamics for aerospace, race car and land applications, in aircraft structures and materials, and in air transport engineering. The Center has one of the best aerodynamics research facilities in the UK. The Handley Page Wind Tunnel Laboratory houses two low-speed wind tunnels, a large industrial aerodynamic tunnel and two-transonic tunnels. The wind tunnels are used by students in undergraduate and postgraduate courses and provide an important research facility for a program of collaborative work with industry. Aircraft structures and materials research concentrates on developing computer-based techniques for static and dynamic analysis of structures with emphasis on aeroelastic phenomena. Air transport engineering embraces the engineering, management, and operational aspects of aviation. Much of the research involves problems that arise in civil or military aircraft operational situations.

The Center has recently installed a flight simulator that can represent the flight behavior of a wide range of aircraft - from Jumbo Jet to a Tiger Moth. It offers a unique opportunity for students to learn about flight mechanics first hand. Design faults are introduced so students experience the effects and compare the behavior to a correctly designed aircraft. The Center works closely with other parts of the School of Engineering in such areas as lightweight structural design, ocean engineering, and thermo-fluids engineering.

Current research activities include: study of flow fields in the working section of wind tunnels with ventilated wall liners to evaluate wall interference effects at transonic speeds; experimental and computational studies of enhanced mixing by smart air jet vortex generators or viscous flow control on wings, aircraft components and diffusers; aerodynamic effects on the performance, stability and control of road vehicles; development of instrumentation and techniques for testing models of land- and sea-based civil structures in wind tunnel simulated atmospheric wind conditions; wind pressure loading and response of buildings and structures in turbulent air flow; wind turbine design and performance; experimental and computational studies on vortical flows emanating from all vehicles, including aircraft missiles under maneuvering flight and high-speed race cars. Most of the research is supported by industry with other substantial support coming from the Research Councils. Research activities include work for British Airways, Shorts, Rolls Royce, Westlands, Airbus and fundamental research funded by research agencies in the UK and Europe.

Conference: Perspectives of MHD and Plasma Technologies in Aerospace Applications, Hosted by IVTAN, Moscow, 24-25 Mar 99.

This workshop was organized by the "MHD Methods of Direct Energy Conversion" section of the Scientific Council of the Russian Academy of Sciences with support of the Institute of High Temperature Materials (IVTAN), Moscow Technical Company (MTC), the private company "Chance", and the European Office of Aerospace Research and Development (EOARD).

It was attended by more than 150 participants from institutes in Moscow, the Moscow region, St. Petersburg, Nizhny, Novgorod, Novosibirsk, Krasnoyarsk, Samara, and Kiev. The Boeing Company and EOARD were also represented.

Four sessions: *Magnetohydrodynamics* (*MHD) Methods and Systems, Plasma Aerodynamic (PA), Shock Waves in Gas Discharge Plasma*, and *Non-Equilibrium Plasma Flows* comprised the workshop. Forty-one papers were presented. A round table discussion by 12 participants formulated the Workshop's conclusion.

Possible application areas for MHD and Plasma Aerodynamic technologies were:

- New PA/MHD methods for the control of (1) internal and external air flow and (2) aerodynamic characteristics of bodies and aircraft
- New PA/MHD methods for the mixing, ignition and combustion control in air breathing engines
- Reduction of drag and improvement of aerodynamic quality of aircraft for a wide range of flight Mach number, by means of (1) modification of shock waves, (2) modification of the separation zone, and (3) influencing the momentum and energy transfer to the aircraft surface
- Heat flux PA/MHD management
- On-board power generation and conversion
- Correction of MHD and plasma thrusters for low and moderate low thrust

New results on theoretical analysis of MHD processes in external and internal flows in aircraft elements and in laboratory rigs were presented. The range of the governing parameter was defined where the MHD interaction is effective and significant. New schemes of on-board MHD generators for hypersonic aircraft were proposed and discussed. In the field of plasma aerodynamics, experimental and theoretical results on the integral and local aerodynamic characteristics of models in supersonic air-plasma flows were presented. New data on drag reduction of models with various types of gas flow discharge were reported. In particular, HF and MW discharges were generated in front of bow shock and in some cases with laser initiation. Rather high effectiveness values (the ratio of the gain of drag force work to the energy input) were obtained for various gas discharge types. It was demonstrated that high enthalpy plasma counter flow jets could significantly reduce the drag in supersonic flows. New analytical and numerical methods for adequate description and prediction of plasma aerodynamic effects were also discussed. Significant progress in experimental and theoretical studies of the structure and propagation of shock waves through gas-plasma systems was demonstrated. Various aspects of non-equilibrium, weakly ionized, multi-temperature plasma flows were outlined. It was shown in particular that non-equilibrium vibration can result in a significant modification of shock wave configuration and drag in supersonic flows.

The Round Table discussion revealed the formulation and realization of key experiments under well controlled conditions providing maximum reliable experimental data on the following topics:

- High velocity flows of non-equilibrium plasma discharge around a body
- Structure and propagation of shock waves in plasma discharge
- Ballistic experiments on high speed flight through plasma discharge with and without externally applied magnetic field
- Effects of gas discharge on various types of boundary layer flows
- MHD control of internal flows
- Plasma chemistry and control of ignition and combustion in high velocity flows
- Interaction of multi-temperature, strong non-equilibrium plasma with shock waves and walls
- Acoustics effects of plasma discharge in high speed turbulent jets

- Improving the accuracy and reliability of plasma diagnostics with emphasis on temporal and spatial resolution
- Optimization of special types of plasma generators for creating electrical conductivity sufficient for MHD applications
- Development of adequate analytical and numerical models
- System analysis and comparison with alternative approaches

It was stated that the practical importance of MHD and plasma technologies developed for control of internal and external flows and aerodynamic characteristics of aircraft by means of direct changes of energy, momentum and state of a gas flow element is evident today. It was also agreed that there exists a need for coordination on current and future activities. The Organizing Committee was highly encouraged by the large number of participants who unanimously supported the idea of holding similar workshops on an annual basis. The official announcement of the Second Workshop on Magnetic and Plasma Aerodynamic will be advertised in the fall ('99). For further information contact Dr. V.A.Bityurin (IVTAN, valbit@dol.ru).).

Conference: Workshop, CNES, Paris, France, 26 – 29 May 1999. The primary host and POC was Mr. Victor Burnley.

Conference: 2nd International Conference on Turbulent Heat Transfer, Hosted by UMIST, Manchester, UK, 31 May-4 Jun 98. UMIST and the University of Manchester, in collaboration with ASME - Heat Transfer Division and the Engineering Foundation, organized the 2nd International Conference on Turbulent Heat Transfer (THT). The Conference was held at the new (August '97) Chancellor's Conference Center where a hotel, a dining hall, and lounge areas permitted participants the opportunity to meet for informal discussion. This format supported the aims of the Engineering Foundation Conferences where all participants are strongly encouraged to fully participate in the day-to-day discussions and activities. The local organizer, Prof. Brian Launder attracted more than 80 participants from around the world and did an excellent job keeping presentations flowing and discussions interesting.

The Conference is designed to bring together turbulent heat transfer researchers to exchange ideas on new strategies or applications and to review ways of removing obstacles to progress. Topics included: Momentum & Heat Transfer in Simple Shear with/without Velocity Extrema; Low-Reynolds-Number Phenomena; Effects of Curvature, Rotation, Buoyancy on Heat Transfer; Impingement & Separated Flows; Effects of Streamwise Vortices on Heat Transfer; Control of Turbulent Transport; Transport across Fluid-Fluid Interfaces; Progress in Instrumentation; and Review of Computational Fluid Dynamics (CFD) Test Cases/Inquests. The concluding remarks included a comment on the "Backward-Facing Step" problem. It was obvious that this traditional and fundamental problem is yet to be solved. CFD is still unable to predict the critical terms such as the re-attachment length. On the other hand, the experimental results are ample, robust, and widely available for the CFD community. It was agreed that the following deserve careful attention:

- three-dimensional effects on reattachment length and
- length scale that needs to be correctly identified.

The next THT will be held in year 2000, at the University of Texas, at Austin, TX, USA. The organizer is Prof. Kenneth Ball.

Site Visit: **Air Force and Army Personnel from the U.S., Saint Louis, France, 10 – 12 Jun 1999.** The primary host and POC was Dr. Hans Pfeifer.

Conference: **Toulouse, France, 14 – 18 June 1999.** The primary host and POC was Prof. Andre Mignosi.

Site Visit: **Dept of Aeronautics and Astronautics; University of Southampton, Southampton, United Kingdom, 29 June – 1 July 1999**. The primary host and POC was Dr. Xin Zhang.

Maj Jerry Sellers
Aerospace Structures and Materials

Site Visit: Defense Evaluation Research Agency (DERA), Farnborough, UK, 19 May 1999. The visit was hosted by Cmd. Richard Blott (RN, ret.). The purpose of the visit was to review the current status of the DERA Space Technology Research Vehicle (STRV) program and on-going research into propulsion and other technologies. The meeting was also attended by representatives from AF/XOR, SMC/TE and AFSPC.

Site Visit: Surrey Satellite Technology, Ltd., Guildford, UK, 20 May 1999. The visit was hosted by Dr. Jeff Ward. The purpose of this visit was to receive the mid-term report on a study conducted by SSTL under an EOARD contract. The project, "Feasibility Study of an Enhanced Microsatellite for Proximity Operations and Hybrid Rocket Demonstration" is focused on leveraging European small satellite technology and launch opportunities to conduct inspection missions in geosynchronous transfer orbit. The meeting was attended by representatives from AF/XOR, SMC/TE, AFSPC and NASA. The final out-brief is expected 16 July 99. For further details about the study, please contact Maj. Sellers.

Site Visits: USAF Academy, AF Space Command, Colorado Springs, CO & AFRL/VS, AFRL/DE, SMC/TE, Albuquerque, NM, 5 – 19 Jun 1999. These visits were made to coordinate with EOARD customers and other parties involved with on-going EOARD contracts or interested in future work.

Col (sel) John Santiago
Computer and Electrical Engineering

Conference: DARPATech Conference, Denver, USA, 8 – 10 June 1999. DARPA presented its twentieth Systems and Technology Symposium. This conference was a unique opportunity to interact with the nation's preeminent technology developers and integrators on the broad range of DARPA initiatives to address the nation's future defense needs. The presentation slides and text can be found at http://www.darpa.mil. DARPA reorganized to include the following offices: Advanced Technology, Defense Sciences, Information Systems, Information Technology, Microssystems Technology, Special Projects, and Tactical Technology. There was major emphasis on integration of technology disciplines/ approaches from information technology, biology, and microsystems. Biological warfare defense was very high priority.

Conference: **International Conference on Photonics, Krystal Hotel, Prague, Czech Republic, 21 – 23 June 1999.** Organized by the Czech and Slovak Society for Phtonics, this conference was attended by over 100 delegates from 21 countries. Prof. Pavel Tomanek (tomanek@dphys.fee.vutbr.cz) was conference chairman. Over half the papers were from the Czech Republic. Conference session topics included: components, devices, and systems in photonics, fiber optic sensors, lasers and applications, non-linear optics, guidec wave optics and photoelectronics, optical information processing and computing, spectroscopy, and education and training in optics and photonics. Of particular interest was 'Silicon-ion Impanted SiO_2 Films:Novel Low-Dimensioal Semiconductor System for Photonic Applications" from the Department of Chemical Physics and Optics, Charles University, Czech Republic. They presented results that exhibit strong visible/IR phtoluminescence (PL). The thermal changes of PL characteristics (efficiency, dynamics, temperature dependence, excitation spectral) of Si^+-implanted samples are closely similar to a typical porous Si. They concluded that the ion-

implantation technique is a very promising way to produce stable and well-defined Si-based light-emitting devices. The primary author is J. Valenta (valenta@karlov.mff.cuni.cz). Please contact him for further details.

Another paper that has AFRL interest is entitled 'Dual Wavelength Dynamic Holography'. The primary author is Vladimir Venediktov (vened@ilph.spb.su) from the Research Institute for Laser Physics, St. Petersberg Russia. The paper has applications for adaptive optics providing arbitrary scaling of the wavefront distortions and simple implementation for measuring wavefront distortions. The final paper that may have potential interest is 'Silcon-based Materials for Optoelectronics: Visible Photoluminescence and Electroluminescence from Amorphous Silicon'. The primary authors are Jurar Dian and Jan Valenta of Charles University, Czech Republic. They reported on room temperature visible photoluminsescence (PL) and electroluminescence (EL) of wide-bandgap hydrogenated amorphous silicon thin films prepared in microwave plasma. The strongest PL was observed from samples with H-Si-H symmetric stretching vibration having a peak near the frequency of 2100 cm^{-1}. Other conference papers may be found at http://www.fee.vutbr.cz/UFYZ/Photonics

Dr. Kent L. Miller
Geophysics

Conference: XVI International Conference on Molecular Energy Transfer (COMET XVI), Assisi, Italy, 20-25 June 1999. [http://www.chm.unipg.it/chimgen/mb/cong/comet.html] Contact: Prof. Piergiorgio Casavecchia [http://www.chm.unipg.it/chimgen/mb/exp3/casavecchia.html] of the Dipartimento di Chimica [http://www.chm.unipg.it/chimgen/mb/mb.html], Università di Perugia. Assisi is the home of the University of Perugia and is located 25 km east of Perugia, the capital of the Umbria region. The purpose of COMET XVI was to survey recent advances, generate new ideas, and map out future directions in the field of molecular energy transfer. The scientific program concentrated on dynamical aspects of molecular energy transfer. Approximately 220 scientists attended the conference including several scientists from the US involved in AFOSR sponsored research. Leaders in molecular energy transfer presented tutorial-style papers at each session. Invited speakers included Prof. D. R. Hershbach, a Nobel Laureate from Harvard University and Dr. Edmond Murad of AFRL/VSB. Molecular energy transfer may determine reaction rates theoretically and in advance of laboratory experiments and so has relevance to the Air Force mission. Although much progress has been made in both theoretical and experimental approaches to the problem, the energy transfer characteristics can only be determined for simple reactions involving light elements.

Dr. Barry McKinney
Information Technology and C4I

Site Visit: DERA Malvern, Parallel & Distributed Simulation Group, POC, Dr. Mike Kirton, [http://www.dera.gov.uk/dera.htm] . Participants from the International Workshop on Knowledge-Based Planning for Coalition Forces [http://www.aiai.ed.ac.uk/~arpi/COALITION/] met at DERA to discuss possibilities for further collaboration and development in the general area of coalition forces. US participants included Dr. James Hendler, DARPA/ISO, Rick Metzger and Dan Fayette from AFRL/IFT, and Dr. Doyle Weishar, Global InfoTeK. Dr. Kirton presented DERA work in Parallel and Distributed Information processing. Much of this work is focusing on distributed simulation and processing using intelligent software agents. Under this general framework, DERA is developing a Coalition scenario to stress the applicability of agent technology. Some of the ideas the group considered for a joint effort include the development of a global information grid facilitated by mobile, intelligent software agents to support a

Command Information System. A key attribute would be to show the ease of interoperability by use of the "Grid" to connect different systems from different countries. Dr. Hendler and AFRL/IFT supported these ideas. Dr. Hendler also described the Control of Agent Based Systems program he manages at DARPA. Dr. Hendler's program includes research from a number of universities and industry including AFRL/IFT and Prof. Austin Tate at the Artificial Intelligence Applications Institute (AIAI), [http://www.aiai.ed.ac.uk/] University of Edinburgh.

Lt. Col. Robert Fredell
International Programs

Site Visit: CSM Materialteknik, Linkoping Sweden, 8 March 1999. Owned 50/50 by Saab and Celsius this specialty defense materials technology company provides basic materials science and engineering capability, full-scale aircraft structural static and fatigue testing, acoustic emission and other non-destructive testing to the Swedish aircraft industry. As part of CSM's work to perform full-scale structural testing of the JAS 39 Gripen multi-role fighter aircraft, they have developed extensive acoustic emission sensors for monitoring growth of damage in both metallic and composite structures. Carbon fiber reinforced composites make up 25% of the Gripen's structure. One of CSM's advances in acoustic emission (AE) monitoring has been static testing of composite parts (150 kHz transducers) and fatigue testing of metallic structures. Mr. Dan Lindahl demonstrated that for composites good coordination with the structural analysis is required to correlate structural "hot spots" but correlation has been excellent. In one case, substantial test-induced damage was avoided because of the high confidence in the AE system. With fatigue testing of metal structures (300 kHz sensors), pattern analysis software has been shown to accurately detect structural changes over time. After 16,000 hours of flight simulation testing, cracks have been detected and located accurately by AE. Contact Lt Col Fredell for additional information.

Site Visit: Munters Aircraft Dehumidification, Tobo and Stockholm, Sweden, and Geilenkirchen, Germany, 9-11 March 1999. This site visit was made at the request of the Aging Aircraft Program Office (ASC/SM, Maj Karl Hart). Though not a truly new technology, aircraft dehumidification has been largely ignored by the US Air Force as a means of improving avionics/electronics reliability and reducing airframe corrosion.

The concept is quite simple. Aircraft that are parked for periods longer than 12 hours have benefited from having dehumidified air blown inside their crew cabin and avionics bays. The associated elimination of condensation on electronic parts during ground time translates to faster startup, reduced electronics failures, and reduced mildew/mold growth on electronics. Using a small ground-based dehumidifier and existing environmental control ducting, dehumidification has worked well for more than a decade on Swedish and Royal Air Force (UK) C-130's and fighter aircraft. In fact, for the extensive avionics suite on the new JAS 39 Gripen fighter, the Swedish Air Force has required specially-designed dehumidification ports. I was struck by the absence of "locker room smell" when I climbed inside a 25-year-old Swedish AF C-130E. I believe the corrosion has to be retarded if the mildew isn't happening,

The Munters dehumidification system has recently been implemented on the NATO E-3 AWACS squadron at Geilenkirchen, Germany. Electronics failure rates are roughly half those of the otherwise identical E-3s used by the USAF with no dehumidification. The principal benefit occurs in electronics/ avionics by reducing corrosion of the electronic connectors. Further benefits of reduced airframe corrosion are probable, but harder to prove in a quantifiable way. Typical military bomber and transport aircraft that sit

unused for days or weeks at a time, can definitely benefit from dehumidification. Typical paybacks for the investment in new equipment have been calculated at less than one year (GAO-audited figures). The only place dehumidification has been found not to work well is with aircraft that DON'T sit still for long (>12 hours) periods of time. This is why the commercial airlines don't use it, as their aircraft rarely stay on the ground. Potential USAF payoffs for this not-so-sexy technology appear to be extremely high.

Munters can be reached at their website [www.munters.com], or through their US representative, Mr. Andy Shelter, at (andy_shelter@munters.com)

Conference: Life Extension Aerospace Technology Opportunities, Cambridge, England 23-26 March 1999. Sponsored by the Royal Aeronautical Society, this first-of-its-kind conference attracted about 100 participants primarily from UK. A handful participants were from the U.S. (three were invited speakers). This British forum, roughly the same as the USAF Aircraft Structural Integrity Program Conference, pointed out the substantial difference in structural life management philosophy between the USAF (durability and damage tolerance) and the Royal Air Force (safe life and fatigue counting).

Meeting: USAF Engineer and Scientist Exchange Program (ESEP), Paris, France 1-4 June 1999. The third regularly scheduled meeting of the ESEP was held in and around Paris. Sites visited include the French National Aerospace Research Agency (ONERA) sites at Chatillon and Palaiseau, and Aerospatiale's Ariane rocket booster assembly facility at Les Mureaux.

AFOSR administers the Air Force's Engineer and Scientist Exchange Program (ESEP) for the Deputy Undersecretary of the Air Force for International Affairs (SAF/IA). ESEP is a formal exchange of government researchers between participating countries. Established over 35 years ago by Defense Secretary Robert MacNamara, ESEP is a career-broadening assignment for military and civilian government scientists and engineers. The US typically sends its participants for two-year tours, while other countries, particularly Germany, tend to send a greater number of participants to the US for shorter stays. Host research agencies offer positions for ESEP participants and the administrative offices in both countries cooperatively make the best matches for placement.

During their tours, participants are treated as full employees of their host agencies, although some restrictions may apply depending on the classification of research at the site. The Air Force has benefited by hosting many participants from other countries and demonstrates its strong commitment by providing the majority of US participants. Though the next ESEP class (2000-2002) has recently been selected, inquiries regarding future participation should be directed to Dr. Jerry Franck at AFOSR/NI (703-696-7316, jerome.franck@afosr.af.mil).

EOARD administratively supports seven Americans recently assigned to ESEP positions in Europe. Most attended six months of language training at the Defense Language Institute in Monterey, CA, prior to their move to Europe.

France- Dr. Victor Burnley and Captain Philip Cali work at Office National d'Études et de Recherches Aérospatiales (ONERA) in Paris. Dr. Burnley's (burnley@onera.fr) area of research is modeling of liquid propulsion systems while Captain Cali (calipm@onera.fr) is studying mesh refinement in finite element modeling of fluid flow around aero shapes.
England- Dr. James Michels works at the Defence Evaluation and Research Agency (DERA) in Malvern on sensor array digital signal processing. Dr. Michels returns to Rome, NY this month.
Germany- Captain Paul Blue (paul.blue@dlr.de) works at the German Aerospace Research

Establishment (DLR) in Oberpfaffenhofen focusing on wing flutter modeling and flight control development. Mr. John Corley (corley@emi.fhg.de) works at the Ernst Mach Institute in Freiburg on the assessment of advanced explosives and their effects on hardened concrete structures. Captain Cindy Klahn (cindy.klahn@usa.net), assigned to the German Flight Test Center (WTD-61) in Manching, Germany, is involved with structural analysis and certification of modifications to a number of flight test aircraft. Ms. Denise Shealey (DeniseMShealey@bwb.org), assigned to the Federal Office of Military Engineering and Procurement (BWB) in Koblenz, manages a number of procurement programs including the HARM missile integration to the Tornado fighter aircraft.

An ESEP participant is in *Australia*. Ms Kathleen Zyga (kathleen.zyga@dsto.defence.gov.au) is assigned to the Defence Science and Technology Organisation in Adelaide where her work involves synthetic aperture radar.

Dr. Martin Stickley
Geophysics

Contract Report: Dr. Michael Damzen of Imperial College, London, has completed his FY 98 EOARD-funded contract (F61775-98-WE014) to assess the idea of using a self-adaptive resonator to achieve near-diffraction-limited operation of diode lasers or amplifiers. His recommendation is: "The most promising route to obtaining high power, diffraction-limited diode radiation is by using the injected adaptive resonator. The injection source would be a single-mode diode laser but would only need to be a low-power device (<1% of the output power of the required amplifier source). The injection diode would determine the wavelength of the system. The results of our analysis indicate that the resonator can be operated efficiently without requiring the non-reciprocal transmission element and that makes the technology most practical". Sources of funding are sought to continue Dr. Damzen's work. A copy of his final report is available by contacting Dr. Stickley. (See more about diode lasers in Conference: EUROPTO/ SPIE, 13 June in this section.)

Conference: **European Materials Research Society Meeting (E-MRS) Strasbourg Cedex, France, 31 May – 4 June 1999.** Partially sponsored by EOARD, the primary host and POC was P. Siffert. Physics of materials for electronics, optoelectronics, photovoltaics, and coatings and thin films were themes of the meeting.

The most interesting paper on nonlinear optical materials was by L. Isaenko and co-authors of the Institute of Monocrystals, SB RAS, in Novosibirsk on $LiInS_2$. While they were not at the meeting (30 days before the meeting, the French upped the number of days in advance for a visa application to 60 thus making it impossible for many eastern Europeans to attend), their paper was presented by a French colleague. The material is orthorhombic, of mm2 symmetry (like KTP), a high nonlinear coefficient (d_{33}~ 18 pm/V), and is transparent from 0.6 to beyond 10 microns. They report having grown it in sizes of up to 20mm in diameter and 50mm long. The material can also be doped with neodymium thus making it possible make a Nd laser in a nonlinear optical material.

It was also reported that $CuInSe_2$ has higher efficiency than GaAs and Si as a photovoltaic. However, its stability is questionable, and obtaining sufficient funding to scale-up the manufacturing process is difficult. This leaves its future in doubt even though it is very attractive in centimeter sizes. The web site [http://www-emrs.c-strasbourg.fr.] contains the conference program, and I can provide a copy of any abstract of interest.

Conference: **NOMA '99 conference, Cetraro, Italy, 4-6 June 1999.** Hosted by Universita'

della Calabria, the POC was Prof. C. Umeton. Papers covered organic, polymeric, photorefractive, multiple quantum well, photonic band gap, and holographic materials as well as liquid crystals. The University of Munchen reported a new organic photorefractive material based on a pi-conjugated polymer, TPD-PPV, with response times approaching 100 microseconds @ 1 W/cm^2 and 100 V/micron. The material simultaneously maintains a large index modulation [5x10^{-3})] which allows for complete internal diffraction in thin film devices such as waveguides.

Bell Labs reported the development of photopolymer materials for high density holographic storage. They claim that their materials will meet the goals of dynamic range, dimensional stability, optical clarity, and flatness, and will support the storage and recovery of high capacity digital data pages at a density as high as 48 channel bits per square micron (~50 Gbytes per 5" disc) with calculated transfer rates in the range of 30Mbytes/sec with bit error rates of 10^{-12}.

The web site for the meeting contains the names of the speakers, and Dr. Stickley can provide copies of abstracts for anyone that requests them.

Conference: **EUROPTO/SPIE and CLEO-Europe Meeting, Munchen, Germany, 13-18 June 1999.** These two meetings piggy-back on LASERS '99, a gigantic exhibition of laser, optics, and materials manufacturers in Europe, and to a lesser degree, the US. The floor area covered by these exhibits must have been 20 acres or greater. It was very impressive to witness the sheer number of companies that have formed mostly in Europe to develop and sell laser-related technology.

Russian laboratories were represented by the 'Laser Association' [www.stu.neva.ru/las] established in April 1990 and located in Moscow. Laser centers from different branches and locations joined forces to promote novel technologies and information exchange, to assure state funding of laser-related programs, and to stimulate international cooperation. Twelve regional centers are located throughout Russia, CIS, and Balkan countries. There are 1100 laser centers (including universities, companies and government and RAS labs), with 80% in Russia, 8% in Belarus, 6% in Ukraine, and 3% in the Baltic states and other countries (mainly Armenia and Uzbekistan). For example, the Vavilov State Optical Institute (12,500 employees in 1990) has become six institutes with less than a 1000 employees total. The Research Institute for Laser Physics (where AFRL/EOARD support a number of projects) supports lasers. They advertised at the meeting the availability of: (1) slab waveguide, 2.5kW RF-excited CO2 lasers; (2) a Q-switched Er:glass laser as a hand-held rangefinder; (3) a diode-pumped, Q-switched Er:glass laser; (4) a 3 micron Q-switched laser with outputs of 25 mJ at 40 Hz; and (5) a high brightness Nd:YAG laser. It is encouraging that they are converting the technology they have been developing into products.

A highlight of the technical sessions was the CLEO Diode Laser session. Speakers from the U. of Bristol (UK), the U. of Ulm (Germany), and the Fraunhofer Institute (Germany) reviewed the evolution of diode lasers over the past 36 years covering electron confinement structures, buried heterostructures, and quantum wells and arrays. Single "GRINSCH" lasers have wall-plug efficiencies of 63%: 2.8W is generated with 1.8V @ 2.8 A. Current densities are 200A/cm^2 with 4 micron waveguides for mode confinement. Data communication rates are increasing 10x every 2 years. 1.6 terabit comm systems are on the market now by Nortel. Achieving low cost lasers is very important. 100 channels can be made on a 0.4 nm grid and having adjacent modes down by 30 dB and with linewidths of ~1 MHz. Lasers can be tuned electrically by use of the quantum-confined Stark effect. Temperature changes cause mode changes resulting in modal noise. Designs are being pursued to deal with this problem. Arrays

have 20 lasers with wavelengths set by distributed feedback. Laser diode arrays are producing as much as 190W of average power. Cost reduction is where the action is now. Efforts to produce high power and high brightness have resulted in 26W output with a M^2<2.4. Such lasers have a power density on the output facet of only 75 kW/cm^2. Unstable resonators are also being explored to improve beam quality. Ultrashort pulse diode lasers can produce pulse lengths as short as 0.3 ps but power is limited to 50W peak. In blue lasers, Nichea is the leader with a lifetime with 10,000 hours; others can barely make 10,000 seconds!

Lt Col (sel) Mark Smith
Life Sciences/ Human Systems

Last Life Science Officer at EOARD: I will be returning to the Bioenvironmental Engineering career field with my change of duty station to Hill AFB, Utah, in July. As of this writing, no successor to my position is anticipated. EOARD remains ready to serve the interests of the Human Factors community at AFRL. Please direct future inquiries for Window on Science, Conference Support, or Special Contracts directly to the Commander of EOARD.

Contract Report: *The Effects of Glutamine Feeding on Immune Function in Air Force Personnel During Intensive Training*. Linda Castell, Oxford University. This prospective study looked at the effects of long-term supplementary feeding of glutamine versus a placebo on aspects of immune cell function, specifically the incidence of infections and effect on mood. Elite runners from a pool of highly trained US Air Force cadets were selected for this study. The generally well regulated cadet life style decreased the possibility of extraneous variables. For all subjects the increase in white blood cells after VO_{2max} tests was similar to that normally observed after a marathon, although much less marked. An increase in IL-6 indicates inflammatory and immune response initiated by injury or possibly infection. A marked decrease in neutrophil activity was observed in these cross-country runners after VO_{2max} tests when compared with other samples during training. There was a decrease in the IL-2 cytokine in the two T-lymphocyte subsets (T-helper cells - CD4; and T-cytotoxic cells - CD8) in the glutamine group compared with the placebo group in the sample taken halfway through the study.

Contract Report: ***Perception by Operators of Approach and Withdrawal of Moving Sound Sources (Auditory Images):*** The investigations were conducted primarily with six subjects (three men and three women) with normal hearing, aged 25-36, who were trained to listen to the sounds beforehand. Six additional patients (two men and four women aged 17-42) suffering from unilateral deafness of sensorineural origin also took part. All measurements were performed in a sound-attenuated chamber. Trains of wide-band noise bursts (20-20000 Hz) were used as stimulus. Approach and withdrawal of the auditory image were modeled by linearly changing amplitude of the signal at two loudspeakers with identical characteristics. To produce the sensation of an approaching auditory image, signal amplitude increased gradually at the near loudspeaker and decreased at the far loudspeaker. To produce the sensation of a withdrawing image, signal amplitude increased at the far loudspeaker and decreased at the near one. The study found:
1. A signal minimal duration of about 140 ms at azimuth angles of 0-60 degrees, and to about 190 ms at 90-degree azimuth was needed to detect radial movement of the auditory image.
2. A signal minimal duration of about 190 ms was needed on the average at azimuth angles of 0-60 degrees, and of about 290 ms at the azimuth angle of 90 degrees to differentiate correctly between

approach and withdrawal of the moving auditory image.
3. The minimal signal duration necessary for movement detection and for differentiation between approach and withdrawal were usually significantly higher in patients with full unilateral deafness, though to a different extent in different subjects. Variability of responses in the majority of patients was also significantly higher than in subjects with normal hearing. Minimal duration values showed no pronounced dependence on azimuth.
4. Differential velocity thresholds were measured at velocities of the auditory image movement from 3.43 to 6.92 m/s and showed an increase from about 0.47 to 0.95 m/s on the average with the velocity increase. Mean value of the relative differential threshold was near to 13% at all velocities used.
5. Mean values of differential velocity thresholds lowered from about 0.8 to about 0.6 m/s over repeated experimental sessions.
6. Differential velocity thresholds showed dependence on movement direction (approach or withdrawal) only at the lowest velocity value of 3.43 m/s.
7. Differential velocity thresholds did not depend on azimuthal angle of the auditory image movement.
8. Individual differences in differential velocity thresholds were found to be relative to velocity and azimuth of the auditory image movement.

Mr. Jay A. Howland
Physics and Ballistic Missile Defense

Conference: Fourteenth Lakeland Symposium on Hetrocyclic Chemistry, School of Chemistry, University of Hull, Grasmere Village, England, 6-10 May 1999. The primary host and POC was Prof. R. Westwood.

Presentation: BMDO Mid Year Program Review, Washington DC, USA, 2-4 June 1999. The primary host and POC was Dr Juergen Pohlmann.

Presentation: Review of EOARD/US Army Contracts and Future Programs, Huntsville AL, USA, 4-7 June 1999. The primary host and POC was Dr Ira Merritt.

Conference: 26th IEEE International Conference on Plasma Science, Sandia National Lab., Albuquerque, NM, USA, 21-24 June 1999. The primary host and POC was Dr. Chris Deeney.

Conference: 12th IEEE International Pulsed Power Conference, Maxwell Physics Int., San Leandro, CA, Monterey CA, USA, 27-30 June 1999. The primary host and POC was Ms Teresa Montero.

Capt Tim Lawrence
Space Technology

Meeting: AFRL/IMOD 7th Technical Working Group Meeting, Tel Aviv, Israel, 23 – 28 May 1999. The 7th AFRL and Israeli MOD technical working group meeting was held in Tel Aviv Israel. General Paul, his staff, and representatives from IAQ, AFSAC, HE, and MN attended the discussions as official guests of Brigadier General Yashin of the Israeli Ministry of Defense. The group was able to visit Israeli industry and government research sites and had technical discussions in the areas of human effectiveness, sensors, UAV's, and munitions.

Meeting: **Discussions on University of Surrey Nitrous Oxide Program, Surrey Space Centre, Guildford, UK, June 1999.** Dr Guy Richardson, Malcolm Paul, and Vadim Zakirov of the Surrey Space Centre hosted a meeting to discuss their research into nitrous oxide decomposition. They have conducted preliminary experiments that show nitrous oxide can be

decomposed by a catalytic reaction at temperatures of 400 C. These results could have application to monopropellant rocket propulsion systems based on a low power requirement for reaction start-up, storability of the propellant, and non-toxicity.

CONFERENCE SUPPORT

EOARD promotes technical interchange by supporting and co-sponsoring technical workshops and mini-symposia at overseas conferences. We often receive in return proceedings and attendance for one or more Air Force representatives. Air Force R&D personnel attending or considering attending European conferences should contact EOARD for further information. For further details on the conferences below contact the liaison officer indicated (see footnotes). **Bi-service and tri-service support efforts are in bold print.**

Dates (1999)	*Location*	*Conference/Workshop Title*	*LO[1]*
1 - 7 Jul 99	Saint-Malo, France	Fourth AFA International Confererence on Curves and Surfaces	JMS
1 - 6 Jul 99	**Heraklion, Crete, Greece**	**Self-Assembling Peptide Systems in Biology, Engineering and Medicine**	**MHS**
2 - 6 Jul 99	Budapest, Hungary	8th International Workshop on Laser Physics (LPHYS 99)	CMS
5 - 9 Jul 99	Edinburgh, Scotland UK	Fourth International Congress on Industrial and Applied Mathematics	JMS
5 - 9 Jul 99	St. Petersburg, Russia	The 7th Workshop on Physics of Compressible Turbulent Mixing www.vniief.ru/mix99	CNR
5 - 9 Jul 99	Palais de Congress, Paris, France	International Conference on Composite Materials 12 www.iccm12.org	RSF
6 - 8 Jul 99	**Pickering, Yorkshire, UK**	**Working Memory: New applications and advances in theory**	**MHS**
11 - 16 Jul 99	Warsaw, Poland	XXIV International Conference on Phenomena in Ionized Gases http://www.icpig99.ifpilm.waw.pl	CMS
12 - 16 Jul 99	Collingwood College, Univ. of Durham, England	Int'l Workshop on Adaptive Optics	CMS
12 - 15 Jul 99	**Windsor, UK**	**European Workshop on Imagery and Cognition**	**MHS**
18 - 23 Jul 99	**Imperial College, London, UK**	**The 22nd International Symposium on Shock Waves (ISSW22) http://www.soton.ac.uk/%7Eissw22/**	**CNR**
19 - 23 Jul 99	University of Kent, Canterbury, England	Wavefront Sensing and Its Applications http://speke.ukc.ac.uk/physical-sciences/main/School/activiti.htm	CMS
2 - 6 Aug 99	**Moscow, Russia**	**Investigations and Applications of Severe Plastic Deformation http://nato.lanl.gov**	**JJS**
16-29 Aug 99	**Winsor, United Kingdom**	**Exotic States in Quantum Nanostructures**	**JMS**
17-22 Aug 99	**TsAGI, Moscow, Russia**	**5th International Symposium on New Aviation Technologies http://www.at-symp.tsagi.rssi.ru/**	**CNR**
22-26 Aug 99	**Trieste, Italy**	**European Conference on Visual Perception http://ecvp99.univ.trieste.it/**	**MHS**
27 - 28 Aug 99	**U. of Natal, Durban, South Africa**	**1999 Quantitative Feedback Theory (QFT) Symposium http://www.ee.und.ac.za/symposium/default.htm**	**CNR**
29 Aug - 10 Sep 99	International Hotel, Millau, France	Microwave Superconductivity	JMS
4 - 10 Sep 99	Saint-Malo, France	The 1999 International Conference on Strongly Coupled Systems	JMS
5 - 10 Sep 99	**Florence - Italy**	**14th International Symposium on Air-Breathing Enfines (XIV ISABE) http://widget.ecn.purdue.edu/~isoabe/**	**CNR**
5 - 8 Sep 99	Bratislava, Slovakia	2nd Electronic Circuits and Systems Conference http://www.elf.stuba.sk/~ecs99	BTM
6 - 11 Sep 99	Dijon, France	Colloquium on High Resolution Molecular Spectroscopy	KLM
13 -15 Sep 99	Sevastopol, Crimea, Ukraine	International Conference on Antenna Theory and Techniques	JMS
13 -17 Sep 99	Tomsk, Russia	Atomic and Molecular Pulsed Lasers	CMS
14 -17 Sep 99	Sitges - Barcelona, Spain	4th European Conference on Applied Superconductivity	JMS
20 -21 Sep 99	Malvern, England	Workshop on Nonlinear Optical Materials	CMS
20 -23 Sep 99	**Seville, Spain**	**International Conference on Ceramics and Bi-metallic Interfaces**	**JJS**
22 -24 Sep 99	**St. Petersburg Russia**	**Applied Aspects of Interface Science (AAIS)**	**BTM**
22 -24 Sep 99	Bucharest, Romania	The 6th Symposium of Optoelectronics - SIOEL '99"	CMS
27 Sep - 3 Oct 99	The Palace of Scientists, St Petersburg, Russia	The Future of Superconducting Rotating Machines	JMS
11 -12 Oct 99	Prague, Czech Republic	COIL R&D Worshop, Prague '99	CMS
18 -20 Nov 99	Bad Radkersburg	Assessment of stress intensity and stress compatibility in large groups under construction	MHS
27 -29 Sep 00	Amsterdam	How eye movements serve the needs of vision in the natural world	MHS

[1] JAH-Jay A. Howland; TL-Tim Lawrence; BTM-Barry T. McKinney; CMS-Martin Stickley; CNR-Charbel N. Raffoul; JJS-Jerry J. Sellers; JMS-John M. Santiago; KLM-Kent L. Miller; MHS-Mark H. Smith

WINDOW ON SCIENCE

EOARD initiates and promotes technical liaison between Air Force and foreign scientists with the Window-on-Science (WOS) program, through which we can arrange and fund visits of foreign scientists to selected Air Force facilities. To nominate a WOS candidate contact your Technical Director or EOARD discipline representative. WOS visitors currently on contract are listed below. For further details contact the liaison officer indicated (see footnotes). **Bi-service and tri-service coordinated visits are in bold print.**

Dates (1999)	*Traveler*	*Country*	*Topic*	*Location(s) of US Visit[1]*	*LO[2]*
6 - 16 Jul 99	Dr. Pierre Villars	Switzerland	New materials modeling	AFRL/ML, Wright-Patterson, AFB, OH, 2nd Intl Conference on Intelligent Processing & Manufacturing of Materials, Honolulu, HI	JJS
6 - 16 Jul 99	Dr. Robin W. Grimes	United Kingdom	Computer applications of materials modeling	AFRL/ML, Wright-Patterson, AFB, OH, 2nd Intl Conference on Intelligent Processing & Manufacturing of Materials, Honolulu, HI	JJS
8 - 18 Jul 99	Dr Yuriy Pokhyl	Ukraine	Superconductivity	Cryogenic engineering and materials conference, Montreal/Quebec City, Canada	JJS
9 - 18 Jul 99	Professor Victor Eremenko	Ukraine	Superconductivity	Cryogenic engineering and materials conference, Montreal/Quebec City, Canada	JJS
9 - 16 Jul 99	Dr. Nadejda Kiselyova	Russia	Materials modeling	2nd International Conference on Intelligent Processing & Manufacturing of Materials, Honolulu, HI	JJS
10 - 17 Jul 99	Dr Jan Franc	Czech Republic	Infrared detector technology	BMDO, Washington DC.; Indigo Systems and Raytheon IR Center, Santa Barbara, CA; Stanford Research Institute, Palo Alto, CA	JAH
10 - 17 Jul 99	Dr. Roman Grill	Czech Republic	Infrared detector technology	BMDO, Washington DC.; Indigo Systems and Raytheon IR Center, Santa Barbara, CA; Stanford Research Institute, Palo Alto, CA	JAH
10 - 16 Jul 99	Dr. rer. nat. Andreas Thust	Germany	Transmission electrom microscopy	AFRL/MLPO, Wright Patterson AFB, OH.	CMS
10 - 17 Jul 99	Professor Pavel Hoschl	Czech Republic	Infrared detector technology	BMDO, Washington DC.; Indigo Systems and Raytheon IR Center, Santa Barbara, CA; Stanford Research Institute, Palo Alto, CA	JAH
11 Jul - 12 Sep 99	Mr. Laurent Perrinet	France	neural networks, artificial intelligence	1999 International Joint Conference on Neural Networks, Washington DC, RRS, University of CA San Diego	BTM
14 - 24 Jul 99	Dr. Petr Bakut	Russia	Fourier telescopy images of rough, remote objects	SPIE Meeting, Denver, CO	CMS
14 - 24 Jul 99	Dr. Valery Mandrosov	Russia	Speckle structure of coherent images	SPIE Meeting, Denver, CO	CMS
14 - 24 Jul 99	Dr. Victor Anatolyevich Karpov	Russia	Fourier telescopy for deep space imaging	AFRL/DEBS, Kirtland AFB, NM, and the SPIE Meeting, Denver, CO.	CMS
15 - 29 Jul 99	Dr. Serguei Dimakov	Russia	Nonlinear optical correction of telescopes	SPIE Meeting at Denver, CO and AFRL/DEBS at Kirtland AFB, NM.	CMS
16 - 30 Jul 99	Dr. Mikhail Vassiliev	Russia	Automatically correcting optical distortion	SPIE Meeting, Denver, CO and AFRL/ DEBS, Kirtland AFB, NM.	CMS
17 Jul - 7 Aug 99	Dr. Vladimir Venediktov	Russia	Dual wavelength dynamic holography	SPIE Meeting, Denver, CO and AFRL/DEBS, Kirtland AFB, NM.	CMS
17 - 29 Jul 99	Dr. Vladimir A. Berenberg	Russia	Holographic arrays	SPIE Meeting, Denver, CO and AFRL/DEBS, Kirtland AFB, NM	CMS
17 Jul - 2 Aug 99	Prof Nathan Blaunshtein	Israel	Radio Propagation	WL/SN for Hanscom AFB	JMS
17 - 29 Jul 99	Dr. Rona Aldo	United Kingdom	Unsteady Aerodynamics Instability in Airframes	AFRL (WPAFB), NCSU (Raleigh, NC).	CNR
18 - 28 Jul 99	Mr. Serhat Sakarya	Netherlands	Spatial light modulator development	The SPIE meeting, Denver, CO and AFRL/DEBS, Kirtland AFB, NM.	CMS
18 - 27 Jul 99	Dr. Orest Ivasishin	Ukraine	titanium metals processing	AFRL/MLLN Wright Patterson AFB OH, ADMA International Twinsburg OH, TIMET Henderson NV	RSF
18 Jul - 27 Aug 99	**Mr Christopher I Wright**	**England**	**cardiophysiology**	**USUHS**	**MHS**
18 - 31 Jul 99	Dr. Alexei Kudryashov	Russia	Turbulence simulation for adaptive optics	AFRL/DEBS, Kirtland AFB, NM, and the SPIE Meeting, Denver, CO.	CMS
18 - 31 Jul 99	Mrs. Tatiana Tcherezova	Russia	Laser beam control	AFRL/DEBS, Kirtland AFB, NM, and the SPIE Meeting, Denver, CO.	CMS
18 - 31 Jul 99	Prof. Vladislav Panchenko	Russia	Dynamics of nonequilibrium gas flow.	AFRL/DEBS, Kirtland AFB, NM, and the SPIE Meeting, Denver, CO.	CMS
18 - 21 Jul 99	Prof. Daniel Donoval	Slovakia	electronics communication, telecommunication	MSE '99 conference, Arlington VA, 19-21 July.	BTM
19 - 28 Jul 99	Prof. James Brian Alexander Mitchell	France	Atomic & Molecular Collision Physics; Combustion	Hanscom, WP, and Edwards AFB.	CNR

Dates (1999)	*Traveler*	*Country*	*Topic*	*Location(s) of US Visit*[1]	*LO*[2]
20 - 29 Jul 99	Dr. Rafik Grygoryan	Ukraine	physiology modeling	AFRL/HES WRS	MHS
22 - 27 Jul 99	Prof. Gerd Luetjering	Germany	Structural materials	AFRL/ML, Wright-Patterson, AFB, OH	JJS
31 Jul - 14 Aug 99	Dr. Ilia Golovnine	Russia	Nanopolyacetylene and YAG laser amplifiers	US Air Force Academy, Colorado Springs, CO	CMS
1 - 7 Aug 99	Prof. Nikolai Smirnov	Russia	Hydrodynamic Ram Problem	AFRL/VACS (WPAFB)	CNR
7 - 22 Aug 99	Dr. Nicola Bonora	Italy	Fracture Design of Aerospace Materials	WLS/MN, WLS/VA (7-12 Aug), WLS/MN (12-15 Aug), USAFA/DFER (18-19 Aug)	JMS
14 - 31 Aug 99	Prof Alexandre Dmitriev	Russia	Wide Bandgap Devices	Rensselaer Polytechnic Institute, Troy, NY. AFRL/SN (Wright Research Site)	JMS
15 - 20 Aug 99	Dr. Raphael D. Levine	Israel	Atmospheric emissions	HRS	KLM
16 Aug - 4 Sep 99	Dr. May-Britt Kallenrode	Germany	solar physics, cosmic rays	Cosmic Ray Conference, Salt Lake City, Utah; HRS	KLM
18 - 31 Aug 99	Professor Robert J Young	United Kingdom	Deformation analysis of materials	AFRL/ML, WPAFB, OH	CMS
3 - 25 Sep 99	Dr. Yakov Benveniste	Israel	Heat conduction in composites	AFRL/MLBC. WPAFB, OH	CMS
4 - 14 Sep 99	Dr Hiltrud Lenke	Germany	Remediation of TNT-contaminated soil	Second International Symposium on Biodegradation of Nitroaromatic Compounds and Explosives, Xerox University, Virginia	MHS
7 - 11 Sep 99	Dr Hans-Joachim Knackmuss	Germany	biodegradation of nitroaromatics	Second International Symposium on Biodegradation of Nitroaromatic Compounds and Explosives, Xerox University, Virginia	MHS
7 - 16 Sep 99	Prof. Fethi Sedat Tardu	France	Active & passive control of near wall turbulence	NASA Langley, AFRL (WPAFB) ; Turbulent Shear Flow Symposium (San Diego, CA).	CNR
10 - 18 Sep 99	Prof Yuriy Sedyshev	Ukraine			BTM
12 - 18 Sep 99	Dr. Farrokh Vakili	France	Coronographic imaging by adaptive optics	Kirtland AFB, NM	CMS
22 Sep - 9 Oct 99	Prof. Dr. Valentin. I. Vlad	Romania	Real-time holographic interferometry	AFRL/SNHX, Hanscom AFB, MA	CMS
26 Sep - 13 Oct 99	Prof Ulf Von Zahn	Germany	lidar measurements in the middle atmosphere	HRS	KLM
5 - 9 Oct 99	Dr Robert G. Triboulet	France	Growth of Zinc Oxide	AFRL/SN	JMS
5 - 9 Oct 99	Dr Darren M Bagnall	UK	Zinc Oxide	AFRL/SN, Wright Research Site	JMS

[1] AFRL Research Sites–**ARS**: Armstrong Research Site, Brooks AFB, TX; **ERS**, Edwards Research Site, Edwards AFB, CA **HRS**: Hanscom Research Site, Hanscom AFB, MA; **PRS**: Philips Research Site, Kirtland AFB, NM; **RRS**, Rome Research Site, Rome, NY; **WRS**: Wright Research Site, Wright-Patterson AFB, OH; Other sites: **AEDC**: Arnold Engineering Development Center, Arnold AFB, TN; **USAFA**: Air Force Academy, Colorado Springs, CO; **ARL**: Army Research Laboratory

[2] TL-Tim Lawrence; BTM-Barry T. McKinney; CMS-Martin Stickley; CNR-Charbel N. Raffoul; JJS-Jerry J. Sellers; JMS-John M. Santiago; KLM-Kent L. Miller; MHS-Mark H. Smith.

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Joint Points of Contact

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